



Farmer seed systems (FSS) in Sub-Saharan Africa

**Assessing farmer-managed seed systems
in Uganda: Case of Gulu, Hoima, Iganga
and Amuria districts**

Implementing Organization: ESAFF



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List of abbreviations and acronyms

AFSA	Alliance for Food Sovereignty in Africa
CSOs	Civil Society Organisations
ESAFF	Eastern and Southern Africa Small-scale Farmers Forum
FAO	Food and Agriculture
FFS	Farmer Field School
FGDs	Focus Group Discussions
FMSS	Farmer Managed Seed Systems
ISSD	Integrated Seed Sector Development
KIIs	Key informant interviews
LRA	Lord's Resistance Army
MAAIF	Ministry of Agriculture, Animal, Industry and Fisheries
MLHUD	Ministry of Lands, Housing and Urban Development
NAADS	National Agriculture Advisory Services
NGOs	Non-Government Organisations
NVRS	National Variety Release Committee
ODA	Overseas Development Agency
OWC	Operation Wealth Creation
PGR	Plant Genetic Resources
PGRC	The National Plant Genetic Resources Centre
QDS	Quality Declared Seeds
SSFs	Small Scale Farmers
TASAI	The African Seed Access Index
WHO	World Health Organisation

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Executive Summary

The agricultural sector is of vital importance for the development of Uganda. They are first and foremost the source of all food and agricultural production. Seeds are genetic resources and carry plant genetic diversity. Smallholder farmers play an important role in Uganda's food systems, with some estimates showing that they meet up to 80 percent of the population's food needs. Seeds are very instrumental inputs that determine development of agriculture among other factors. Quality seed is a key input for agriculture with an immediate effect on agricultural production and productivity. The bulk of farming in Uganda is still mainly done by smallholder farmers and it is clear from previous studies that Farmer Managed Seed Systems (FMSS) stands out as the most reliable and affordable source of seeds for the vast majority of smallholder farmers. The study showcases and unpacks FMSS by presenting understand on how Farmer Managed Seed Systems (FMSS) work in Uganda and how it relates with other components of farmer systems. The study also present case studies of FMSS to challenge the current narrative on seed and ultimately influence policy and also aimed at cultivating buy in for FMSS amongst CSOs and policy makers.

The study followed a multi-method design and these were both qualitative and quantitative like Key informant interviews (KIIs) with selected stakeholder for example district local leaders and NGOs; Focus Group Discussions (FGDs) with selected farmer group members from the different districts; and Document review of relevant documentation on farmer managed seed systems. The study targeted local smallholder farmers, CSOs and other organisations that are working with smallholder farmers, and selected officials from the local governments from Gulu, Amuria, Hoima and Iganga district. The study was conducted in Hoima, Iganga, Gulu and Amuria district.

According to the results of the study, it shows that most smallholder farmers farm on an average of 1 to 6 hectares. The study points out that the smallholder farmers who are practicing the Farmer Managed Seed System in the districts of Gulu, Iganga, Amuria and Hoima all planted cassava, maize, sweet potatoes and beans in the last planting season. According to the results from FGDs, in the past decades smallholder farmers used to exchange seeds among themselves especially women and the seeds were indigenous. Smallholder farmers also stated that seed is important for food, for sale in order to educate the children and also is used for cultural ceremonies for example giving birth to twins, when one builds a new house, introduction ceremonies etc. Smallholder farmers testified that the local seeds are very easy to access for example they are easily found within the community. Smallholder farmers decried the fact that their local seeds by law can't be legally shared within their communities and beyond unless it becomes a QDS of which the process takes long and no easy for smallholder farmer.

Smallholder farmers are preserving and promoting local and traditional seeds in their respective districts. The promotion of FMSS has also seen many smallholder farmers coming up to be part of the process of reviving the use of locally generated seeds in the community. FMSS have encouraged seed sharing among smallholder farmers in the community and hence creating unity among the farming community. The study results depict that there has been little support given by the government in promoting FMSS through funding and technical support.

Findings from the study reveal that seed is an important vehicle for improving agricultural output, and major development goals such as food security, sustainable rural development and poverty reduction. Seed is a crucial input in any form of crop production and one of the most precious resources in farming. The right of farmers to save, use, exchange and sell farm-saved seeds and other propagating materials is a central component of Farmers' Rights as enshrined in the FAO Treaty on Plant Genetic Resources for Food and Agriculture. The Seeds and Plant Act, 2006 and the draft National Seed Policy do not address the right of farmers to use, exchange, and sell their saved seeds. The National Seed Policy recognises both the formal and informal seed systems. The policy also recognises the addition of a Quality Declared Seed (QDS) class to bridge the gap between formal and informal systems. Results from the analysis also show that there is insufficient support for farmer seed systems and this is evident with the policies and laws that are being developed and passed by government.

Seeds have long been a part of the cultural heritage of different societies in Uganda, seeds are an integral part of many rituals, ceremonies and festivals that celebrate the cycle of birth, life and death. The practice of seed saving has been a cornerstone of farming communities that made agriculture their way of life.

Recommendations included the need to strengthen the capacity of smallholder farmers that are engaged in saving seeds to value and protect these local genetic resources; Build capacity of community seed banks to strengthen their technical and managerial expertise in alignment with the policies governing seed; There is need to promote the documentation of local and indigenous seed varieties; More research is needed to be done in the area of FMSS sustaining in the changing climatic conditions.

Authoring organization

Brief about the organization

ESAFF Uganda is a small scale farmer-led movement formed to facilitate processes through which smallholder farmers' development concerns can be solicited, articulated and ultimately addressed through local and national policies and programs. The formation of ESAFF in 2002 was a direct response to the need to create a forum where Small Scale Farmers (SSFs) are able to deliberate on and voice their concerns. ESAFF Uganda works to enhance the SSFs ability to make informed decisions and participate meaningfully in development processes through capacity building, advocacy, research and institutional development. The forum was established in 2002 to bring together small scale farmers into a social movement to build common aspirations, learning and linkages. ESAFF Uganda brings together small scale crop farmers, pastoralists and traditional fisher folks. ESAFF Uganda works towards a vision of an empowered self-reliant small scale farmer. The mission of ESAFF Uganda is to nurture the participation of small scale farmers in sustainable development processes, for self-reliance through advocacy, capacity building and institutional development. ESAFF Uganda operates in 30 districts of Uganda.

Brief about our seed work

ESAFF Uganda promotes Farmer Managed Seed Systems (FMSS) because it addresses issues related to seed security and sovereignty of smallholder farmers. This reduces monopolies in the seed sector and increases farmers' seed choices. Smallholder farmers have since been advocating against laws/policies that prevent farmers from saving or exchanging seed hence undermining the farmers' rights or seed sovereignty. ESAFF Uganda has been implementing models like Community Managed Seed Security model (CMSS) that protect the seed security and sovereignty of smallholder farmers. The model mainly aimed at providing farmers with a practical, harmonized and systematic approach of promoting community-led seed security; this was done in Gulu district, northern Uganda. Through this model, smallholder farmers are taken through the eight modules of the model where they gain knowledge on seed rights. The major objective of the Community Managed Seed Security model is to improve agricultural productivity and seed sovereignty of smallholder farmers through increased access to affordable good quality seeds of their choice from a trusted source and within a timely manner. Smallholder farmers are also exposed to some of the techniques used by other communities in preserving their own seed through learning visit. Smallholder farmers use the knowledge they acquire to set up their own community seed banks where they preserve different varieties of seed as well as sharing the seed amongst group members and the community at large. In the process smallholder farmers have initiated engagements with their local and national leaders where they propose strategies through which government can promote seed rights among communities as well as supporting women to secure their interests and assert their views in relation to seed rights.

To further promote FMSS, ESAFF Uganda established farmer field schools to improve access to Plant Genetic resources (PRG). ESAFF Uganda has so far established two farmer field school schools in Amuria district. The FFS empowers farmers through field based experiential learning, it enables farmers to make their own observations, analyse these observations and use the results as a basis for conclusions and decision making. Smallholder farmers are involved in deciding the days of the meeting, identifying land for the school, formulated their leadership, set the bye-laws and breaches, set breeding objectives among others. Each school consists of 30 members and 6 subgroups. Through FFS, smallholder farmers have engaged in breeding their own seeds hence improving the local varieties through selection of best traits. Smallholder farmers carry out agro-ecosystems analysis of the field where they observed and record.

Purpose and objectives of the study

The bulk of farming in Uganda is still mainly done by smallholder farmers and it is clear from previous studies that Farmer Managed Seed Systems (FMSS) stands out as the most reliable and affordable source of seeds for the vast majority of smallholder farmers. Under FMSS, farmers work at a local level to remain the custodians of local seed selection, storage and management. The right to healthy and sustainably produced food is at the heart of food sovereignty. Yet without access to quality, affordable seeds and the legal right to save, select and share seeds, no farmer or consumer can fully achieve this sovereignty. FMSS is proving to be a powerful tool in the struggle to reclaim seeds and biodiversity. This study builds on existing bodies of work by adding more case studies and insights, drawing conclusions and offering recommendations for strengthening support around FMSS.

The study showcases and unpacks FMSS, how they work and how they contribute to food and seed sovereignty and maintains and enhances proper nutrition. It also provides an overview of the main threats to FMSS. The case studies presented speak to the diversity, resilience and rich traditions that exist across the country.

Study objectives:

1. Understand how Farmer Managed Seed Systems (FMSS) work in Uganda and how it relates with other components of farmer systems
2. Present case studies of FMSS to challenge the current narrative on seed and ultimately influence policy
3. Cultivate buy in for FMSS amongst CSOs and policy makers

Study methodology

Introduction

This chapter highlights the rationale for the methodology and choice of stakeholders, study design, interview techniques, and discussions of limitations of methodologies. This chapter also explains the data management process and data analysis.

Rationale for the methodology

The choice of the methodology was to eliminate the gaps in existing pool of literature and contribute to literature on farmer managed seed systems. The objective of the study was to understand how farmer managed seed systems work in Uganda and how it relates with other components of farmer systems hence the use of FGD because of its ability to obtain in-depth information on concepts, perceptions, and ideas of the group and it creates a more than a question-answer interaction. Key informant interviews also gave in-depth interviews with people who know much about Farmer Managed Seed Systems and how they impact in communities. KII also contributed a lot to understanding the underlying motivations and attitudes of a smallholder farmers in the different districts. The choice of the study methodology was useful in generating suggestions and recommendations.

Study design

The study mainly targeted local smallholder farmers, CSOs and other organisations that are working with smallholder farmers, and selected officials from the local governments from Gulu, Amuria, Hoima and Iganga district. Apart from local smallholder farmers, other stakeholders were purposively selected due to their respective roles. Triangulation of both qualitative and quantitative techniques for data collection was used to enable rich and complete data is collected for the study.

Justification of study districts

Conflict with the Lord's Resistance Army in the Northern region of Uganda was stabilized in 2008, the LRA war caused social and economic distress to the region. Since the population was depending on food relief, smallholder farmers lost most of their indigenous seeds and farmer seed systems were as well destroyed. Smallholder farmers in Amuria and Gulu district then started building their farmer seed systems on indigenous seeds. In Iganga district the commercialisation of sugarcane growing instead of growing more food crops have led to the loss of indigenous seed varieties in the Busoga region. This has made Busoga region the poorest in the country. Some smallholder farmers are reviving the farmer seed systems in Iganga district to be able to promote seed security and sovereignty which is important for poverty reduction in the region. Hoima district is a special case in the study given the "oil rush" in the region. With the discovery of oil, focus has shifted to industrialisation which comes with a lot of environmental

degradation and distraction of biodiversity, agriculture is at risk as smallholder farmers have attested the loss of land and indigenous seeds. It is predicted that the Hoima district and the entire region will likely suffer the effect of climate change most. Smallholder farmers are struggling to protect their seed security and sovereignty through the promotion of farmer managed seed systems despite the little support from government.

Data Collection Methods and Tools

Data collection was through enumerators. The enumerators hired possessed a minimum of Bachelor's degree with previous experience in data collection, and knowledge of the local languages in the enumeration areas. The study involved a very extensive in-depth desk review of available documentation by both government and non-state actors. The extensive desk review was very useful for gathering facts to enrich the report. The study employed a purposive and non-probabilistic sampling strategy and conducted consultations with key stakeholders. The study followed a multi-method design and these were both qualitative and quantitative, namely:

1. Key informant interviews (KIIs) with selected stakeholder for example district local leaders and NGOs.
2. Focus Group Discussions (FGDs) with selected farmer group members from the different districts.
3. Document review of relevant documentation on farmer managed seed systems. This helped to ascertain facts relevant to the study. Others included: reports, policy documents by government as well as other stakeholders.

Study Respondents

The study targeted local smallholder farmers, CSOs and other organisations that are working with smallholder farmers, and selected officials from the local governments from Gulu, Amuria, Hoima and Iganga district. These districts represent three regions of the country including eastern, northern and western. In each of the districts, 1 FGDs was held with smallholder farmers with an average of 10 participants each, a total of 48 (20 male and 28 female) smallholder farmers took part in the FGDs. 12 Key informant interviews were conducted with district leaders, government officials and other stakeholders.

Data management process and data analysis

Upon completion of field data collection, the consultant used a variety of methods of data analysis like meta-analysis. The data collected was then analysed and compiled into a very informative study report. The study report was presented using the format agreed upon by AFSA/GRAIN.

Ethical Considerations

During data collection, ethical issues were considered. These included: confidentiality and consent of participants. Consent was got from every respondent. The study research team assured respondents that the information collected would only be used for the study purposes. During this study, in order to protect the privacy of the respondents and to avoid any negative consequences from this study, respondents were asked whether their names and photos could be used or not in this report.

Limitations of the study

The limitations of study included the following:

1. Time constraint especially for fieldwork, which made it difficult to secure meetings with all key stakeholders and policymakers.
2. As the primary data and observational method has its own limitations that affect the way the study results are used.

Presentation of results

Introduction

This chapter presents the findings of the study based on the data collected from the respondents and this is done as per the research objectives.

Sources of seeds and acquisition forms

Land Ownership and Crops in the Farming System

According to the results of the study, it shows that in Amuria district most smallholder farmers' farm on an average of 4 to 6 hectares. Most smallholder farmers in Gulu district have an average of 5 hectares of land that they farm on. Findings from Iganga district show that smallholder farmers have from 1 hectare to 2 hectares of land while those with 5 hectares of land are the farmers having the highest farming land. Smallholder farmers in Hoima district have only 1 hectare of farm. The study also revealed that most smallholder farmers from Gulu district are using the clan land or the community land while some few farmers bought their land in which they are using for farming purposes with only one person among those interviewed who is involved in renting of the land used for farming. In Amuria district, all the respondents testified that all of them have just inherited land from their ancestors, they also noted that there is no community land like for the case of Gulu district. Unlike Hoima and Gulu district were smallholder farmers aren't allocating land for livestock, smallholder farmers from Iganga and Amuria districts are involved in both crop production and animal or livestock rearing. The respondents in Iganga and Amuria stated that a large proportion is mainly for crop production while small piece of less than a hectare allocate for livestock. However in dry seasons when they have harvested all the crops, animals are grazed in all the land available.

The study revealed that smallholder farmers in Iganga district have no new crops introduced in the farming system in their community though they pointed out that in many cases what has changed is the variety/species of the crop that they are growing. Most farmers in Iganga district have stopped growing crops like cotton, bambara nuts (Empande), sunflower, pumpkin, millet among others. Smallholder farmers in Hoima and Amuria district testified the introduction of new crops in the farming system. Crops introduced in Hoima district include onions, maize, sorghum, ginger, groundnuts, and cassava while in Amuria district crops introduced include sorghum of a new variety called cilli but it is not yet common and most farmers have failed to adopt growing it because when they planted the sorghum seeds, the seeds failed to germinate leaving those farmers with many questions. Smallholder farmers in Amuria district have also stopped growing most crops locally known as "abiri" (tall sorghum), "epena", "ebalo" and "akolil" in the farming communities. The new crops that were introduced in their farming system in Gulu district includes bananas, the new species of cassava called "odok", the black and white maize known as "lak dyang", the Nam II soya beans and the new species of rice which has been introduced called "sindani".

On the other hand smallholder farmers in Gulu district have also stopped the growing of some crops including some varieties of maize, groundnuts and soya beans, the reasons why they stopped growing those crops is because they have maize pests and diseases for example the army worm. The other reason the respondents gave is that the seeds for those crops are lost and not on the seed market.

Meanwhile in Iganga district smallholder farmers stopped growing certain crops because the market for the produce of these crops isn't available and the buyers also offers low prices for such crops and this makes farmers not to have interest in growing them, some crops are taken as old people's crops for example millet, cotton, bambara nuts, pumpkin and others since these crops are mostly grown by the old people. The study also found out that the reasons why some smallholder farmers in Hoima district have dropped certain crops is as a result of the change in the farming methods through the introduction of NAADS programme in the villages where people have continuously ignored the traditional or local crops since the seeds that are received from NAADS which lasts only for 2 years while the traditional crops would last for a period of 5 years. The challenge with these new seeds is that they rot easily compared to the traditional ones. The smallholder farmers also stop growing particular crops if they produce less yields and if they are not resistant pests.

Smallholder farmers in Amuria district said that they stopped growing certain crops because of different reasons including those crops were attacked by specific diseases like witch weed, that attacks the tall sorghum (abiri) hence affecting the yield performance of this tall sorghum hence farmers abandoned it; the tall sorghum (abiri) have no market because most of the people in the community do not have knowledge about them; some crops delay to mature for example the tall sorghum variety which takes about one year till full maturity and; some plants like "ebalo" are very difficult to prepare and they requires over pounding to make it usable for pasting food. The study also revealed that the farming motives have changed the farming systems besides the challenges that smallholder farmers are facing in Hoima district. A majority of the farmers grow to sell and get money meanwhile in the past farmers used to do agriculture for only household food security hence market was secondary.

Smallholder farmers from Iganga district noted that land has become small because it has been fragmented yet previously large pieces of land were available for farming hence influencing the farming systems in the community. They also said that the government is no longer concerned about the promotion of agriculture for example the Agricultural Extension officers who no longer check on farmers yet previously it was a must for them to check on the farmers and give them advice accordingly. During the same FGD, smallholder farmers from Iganga district also said that there is change as a result of many diseases and pesticides affecting crops, which have come up as a result of the changes in the varieties of crops. The current species are not resistant to diseases and pesticides and this used not to be there.

Crops Growing, Seed Use, Custody and Safety in the farming system

The study points out that the smallholder farmers who are practicing the Farmer Managed Seed System in the districts of Gulu, Iganga, Amuria and Hoima all planted cassava, maize, sweet potatoes and beans in the last planting season. However some smallholder farmers in Amuria and Gulu districts planted sorghum, millet, green gram, cowpeas and groundnuts differently while those from Hoima and Iganga district planted simsim, soya beans and matooke. In Iganga district those crops were grown mostly because they can be used for subsistence and for sale to realize some money, the other reason given was that the crops grows faster and this also applies to the respondents in Gulu district. However in Hoima they grew those crops because it favours their land and also brings in a lot of money to them. The farmers in Amuria district pointed out that the reasons why they grow those crops is that they are fast maturing, reliable market after harvesting and they are resistant to various pests and diseases. In the order of importance, most of the farmers prioritised the need to grow crops for food in their household and secondly the need for selling.

Overall smallholder farmers ranked the listed crops in the order of importance, the first being the most important while the last being the least cassava, maize, beans, sweet potatoes, bananas, millet, groundnuts, soya beans and green gram.

“We are growing crops that we can freely access in our community rather than those that bring seed dependence” Farmer, FGD, Iganga district

According to the FGD in Gulu, Amuria and Iganga districts, smallholder farmers acknowledged that they use both the locally preserved seeds for example beans and sweet potatoes and hybrid seeds given by either the government or the private partners that deals in the seed supply for example cassava and maize seeds. However in Hoima district, the smallholder farmers in the community emphasised that they only use the local seeds that they multiply and store for themselves. Result from the study shows that majority of seed in all the districts is own seed that the farmers keep them and they plant in the next planting season. The government is also distributing seeds through the program of Operation Wealth Creation (OWC) but it is mainly being done on maize and mangoes seedlings. Some smallholder farmers in Iganga district said that they borrow their seeds from their neighbours or get free seeds from friends and relatives through seed exchange. In the selection criteria of the own seeds, the seeds of good quality are selected during harvesting then stored and later on replanted in the next planting season. The criteria for selection of sorghum, millet and maize is that the farmers select healthy cobs or heads free from pests and cobs with big grain size. These selected cobs or heads are then stored separate from the rest. They are kept for planting in the next season. This is done in all the study districts. On the other hand, the farmers in Gulu district mentioned that what is important in the seed selection is to get a healthy, strong and high yielding seeds to be preserved and planted.

The results of the study also indicates that in the seed conservation in all the districts is done in sacks or polythene bags, kitchen, community seed banks for example Bukanga Tukulere Walala Farmers' Cooperative in Iganga district, containers and granaries mostly used by the old people in Amuria district. All these avenues are being used by the farmers to store and keep the seeds safe for planting in the next season and it is being done at the community and at family levels in homes. In Iganga the smallholder farmers use chemicals or pesticides to kill the pests and also to prevent diseases from attacking the seeds and also in addition they use the containers especially metallic containers and plastic air light containers to protect the seeds from insects and rotting to preserve it very well for planting. In Amuria district the local approach used for conservation of beans is beating it and storing it together with its husks in the same bag. Local materials like the neem tree leaves, red pepper, “lantana camara” leaves are added to the seeds being preserved. On the other hand the study reveals that all smallholder farmers interviewed in Gulu district are not using chemicals but instead they are only using cow dung and other ways for preserving their seeds for example they preserve beans by normally using “kanlao” to keep it for the next planting season.

In Iganga district, the study revealed that there are people in the community who are particularly known for keeping seed like those who keep maize called “mawalampa”, these people sell, exchange or share the seed with smallholder farmers when it comes to planting period. In Hoima district, there are also cases of individuals who have dedicated their lives in storing seed sand then supply to a few people in the community at free cost but most of the farmers occasionally exchange the seeds with the farmers from other districts like Buliisa district. In Amuria and Gulu districts, there are no seed custodians responsible for maintaining the local seeds hence the seeds are kept within homes of the farmers as it waits for its planting. The study also shows that most of these people who provides custody to seeds are prominent farmers in the community and some are elderly people who specialize in growing particular seeds only and this motivates them not to lose the seeds hence most of the other farmers come and get it from them when it comes to the planting season and in most cases they only supply to those who go to them and ask for the seeds because they have very little quantities and so they are not in position to supply the whole village. The seeds are always sold or exchanged with other seeds/varieties or items. Sometimes these seeds are given out as part of the in kind payments.

The study also indicates that farmers are very free to access the seeds in the community without any special law hindering them.

“I can openly say there are no laws here when it comes to exchanging of the seeds because for me the crops that I planted in the last planting season I just went and got it from “cankwiyagoro” (a group of farmers) and I was given freely and no condition was attached to the seeds that I was given. So you see how we are free to get seeds here in our village” Said a respondent in Gulu district.

Like for the case of Gulu district, smallholder farmers in Iganga district exchange of seeds is done by consensus where the two parties agree to what they are both interested in hence sharing or exchanging the seeds freely.

Evolution of seeds in farmer managed seed system

Seed Sources in the Community

According to the results from FGDs, in the past decades smallholder farmers used to exchange seeds among themselves especially women and the seeds were indigenous. It is from here that these seeds were passed on from generation to generation. Whenever a woman was planting seeds, a girl would be watching, they learnt about these seeds. Whenever a household did not have seeds, they would exchange with other households. Those who have granaries, they would store seeds for the next season but they started disappearing because of the scientific method of farming that came with the use of pesticides hybrids. Some seeds which were planted for purposes like for ceremonies, when some of the ceremonies were not performed anymore then those seeds disappeared. The communities used these seeds as household security at the household level. The study also reveals that the seeds were obtained from the previous harvested seed which was conserved and or kept very well specifically for planting in the next season.

“To me I see that the seeds that the government is giving to farmers is improved and when you plant it does not yields well” Claimed a famer in Gulu

Alternatively, some farmers these days purchase seeds from the market because some farmers can't manage to keep seeds safe from the time of harvest to the time of planting since they are mostly affected by pests and diseases for example beans. Other seeds are also being evolved and coming into existence as a result of the government and private companies which started to distribute the seeds to the farmers. Government through the Operation Wealth Creation (OWC) program and NAADS is distributing improved seeds of maize and mangoes seedlings and another example is Mukwano, Equatorial seeds, Victoria seeds and Uganda Farmers Association, private seed companies which are also distributing hybrid sunflower seeds, there are also bulking centers at the sub county headquarters distributing the sorghum seeds to the farmers and thus the evolution of seeds in the community.

Roles of family members within the Seed System

The study identified different roles that are played by different family members in the seed system. The roles that children play includes helping a lot in the seed preparation for example the groundnuts they help a lot in the removing of the hard shell so that the seeds are ready for keeping and planting. Also when it comes to the planting of the seeds like a case in point is the groundnuts, beans, maize, cassava and other seeds, children help a lot in the dropping of the seeds in the holes created during the planting process of seeds since they are faster, they also help their parents in garden preparation, accessing seed from relatives and neighbours, weeding of the plants in the garden, transporting seeds, packaging, drying of seeds and chasing away of the birds both in the garden and during drying period.

The study revealed that the roles of women includes being custodians of the seeds because they know when to plant, what to plant and how to select seeds. The selection was based on the different functions of the seeds subjected to withstand drought, pests and diseases, ability to be cooked and the nutrition value of the seeds, preparing the gardens, planting of the seeds, weeding of both seed and crops in the garden, harvesting and drying of the harvested seeds and crops. The study also found out that the roles played by men include majorly help on issues like selecting sites and or seeds for planting or decision making, opening land where the seeds are to be planted as this task seems to be tough for women according to the study. Men also help in identification and preservation of seeds and they also look for the seeds to be planted where necessary especially if the seeds are inadequate in the location or in the community and requires moving to faraway places and here men look for them especially for the crops that needs replanting for example cassava. They also engage in other roles like opening the land for planting or ploughing, mulching, digging holes like for bananas, cassava, maize, groundnuts among others, spraying the crops with insecticides and pesticides and finally men also help in weeding and harvesting of the crops.

“Women are the most important people in the seed system in our area because they control and store seed. If a women doesn’t have her own seed, she is powerless. It’s that simple.” Male farmer, FGD, Hoima district.

Relationship between Seed and Culture

According to the FGD in Iganga district, smallholder farmers stated that seed is important for food, for sale in order to educate the children and also is used for cultural ceremonies for example giving birth to twins, when one builds a new house, introduction ceremonies. In Amuria district, it was revealed that seeds like millet and simsim are of great importance in that it is used to feed mothers who have just given birth for them to be strong and healthy and also millet is used for brewing local alcohol called “Ajono” that excites and brings refreshments to the local community including farmers. Seeds also produces food for example paste from groundnuts makes good sauce especially mixed with greens for women who have newly given birth, sorghum is also mixed with cassava to make the local flour (bread) called “atapa”, cassava flour is culturally important as bread and suitable to eat with meat.

A respondent stated;

“An Itesot man is always excited and gains a lot of appetite when he sees “atapa” (a combination of cassava and sorghum flour) and meat. This is really a perfect combination for his diet”

In Hoima district, people use Nkole (greens) to prepare food for in-laws for certain functions like introduction, seeds for example simsim are used while making rituals to the ancestors, millet is also used when babies are born and it is placed on the umbilical cord to fastens healing and finally mothers who have just given birth eat millet to gain energy and also increase on their blood. Results show that all the seeds used in cultural practices are traditional seed and that is one of the reasons why farmers are preserving them.

A respondent stated;

“In all our traditional ceremonies we use traditional seeds because they are the ones our great great grandfathers left for us so we continue using them out of respect for our ancestors.”

Situations of Local/traditional Seeds

The study justified that in the current situation, there are some households which have local indigenous seeds especially those households with old women and old men though some households that have young people are also planting indigenous seeds. It also pressed that the seeds can be local but when they are not indigenous in that the local seeds can be bought from the market.

The study also revealed that currently there is improvement in the seed system and many people can now differentiate between the improved and local seeds. In Gulu district, some smallholder farmers are re-adopting the planting of local seeds as a result of the Farmer Managed Seed System (CMSS) model intervention designed by ESAFF Uganda. It has also been noted according to the study that some farmers are planting the hybrid seeds mostly because they are freely given by government but with reservations since they say that the hybrid crops unlike the local seeds require the use of chemicals hence having health rights implications. The study also noted that in Iganga district the local seeds are being affected by pests and diseases so much, they also take too long in the garden to mature, many seeds or varieties of local seeds are now lost as a result of the introduction of the hybrid or the improved seeds and finally the local seeds do not give good or high yields as compared to the improved or hybrids.

A respondent stated;

“Though am still preserving our traditional seeds, they also have challenges with this changing climate that really need to be addressed.”

In Amuria district, most indigenous seed varieties like groundnuts have disappeared and being replaced with the improved varieties whose adoption is increasing very fast among the community. The number of people producing local seeds has also reduced and so the volumes of locally produced seeds are small. However the people still holding on to the local varieties are the old people in the community who are aware about the indigenous seed and most of them still have the knowledge on indigenous seed. The results from the study also shows that the yield of local seeds has also lowered. While relating the local seeds to culture and knowledge, in Iganga district the local seeds are taken as medicine and when someone is sick they are given for example the mothers who have newly given birth.

Involvement in farmer managed seed system

Reasons for using Local Seeds and Challenges faced with Locally Conserved Seeds

During the FGD in Gulu district, smallholder farmers raised said they use the local seeds because they are healthy and do not contain the chemicals. It was also found out that local seeds are sweet and nutritious and very natural. It can be kept for long and for generations and generations, it can also be replanted for a long period of time without losing its quality. They went on to say that the local seeds are resistant to some weather shocks and climatic changes a case in point is drought for example some local beans even if it is hit by heavy sunshine it can just dry but when rain comes back it grows well and improves faster hence considered drought resistant. Smallholder farmers also noted that some local seeds like the local species of tomatoes is sweet and can be used as medicine, they are small but very good for good health, others said that some women eat local millet immediately after delivery so as to gain energy and regain blood. Smallholder farmers from Iganga district also stressed the importance of using it as a medicine. Some also said that simsim acts as a traditional medicine for diabetic people in the community. According to results from Hoima district, smallholder farmers testified that the local seeds are very easy to access for example they are easily found within the community farmers and members of the community. They also added that the local seeds are affordable in terms of the prices, this is because the seeds are within the community and are easily accessible.

A farmer in Iganga district happily said;

“In our community here children who always have any difficulties in either breathing or talking were always given simsim paste and this would heal them very fast and in the end the family members would be very happy and rejoice”.

In Amuria district, most of the respondents stated that most of the local seeds are not sprayed or don't require the use of chemicals for example potatoes, millet and simsim while some local seeds are resistant to disease and pest. The local seeds are very tolerant to weed infestation since weeding could be done only once up to the harvest time and still realize good harvest. They also added that the local seed has good taste and very good nutritive value as compared to the improved seed that are supplied by the private seed companies and the government. Respondents also agreed that the local seeds are very easy to store as compared to the improved seeds when they are harvested for planting in the next planting season for example Maize, millet, groundnuts, beans among others where the farmers can only apply the use of ash and it can be kept for a long period of time. The farmers also said that local seeds can be replanted for a number of seasons and for a long period of time without being depleted in value and quality. FGD in Iganga district also revealed that smallholder farmers plant the local seeds so that they can be used during ceremonies or parties in the community for example traditional ceremonies and cultural ceremonies, simsim is mixed with coffee and it is given to the in-laws and they eat and enjoy hence building a long lasting bond and relationship between the two families forever. The local millet is also used in the traditional rituals to appease the spirits of the ancestors and it is intended to fight hunger in the community since people would mostly rely on it.

Smallholder farmers involved in the study narrated that;

“Without seeds, there is no life and of which the main source of seed is the informal seed sector which deals with local seeds so it needs not be wiped off and thus there is need for the protection of the local seeds.

In Iganga, Gulu and Amuria districts the study shows that the local seeds have a very long maturity period, for example cassava, pigeon peas, sorghum (“abiri” species) takes a period of more than one year to mature. The study also found out that the local seeds have low yields in the produce after harvesting. There is little documentation and dissemination of information of locally preserved seeds in the community hence less attention is being paid to the locally conserved seeds by the government and development agencies. This in the end brings a mix up between the varieties of seeds and the identification of these seeds becomes a challenge to the farmers as a result of little knowledge and awareness given to them on the local seeds that exist in the region. In Hoima district, most of the respondents mentioned that there is scarcity of locally conserved seeds in the area and also stressed that the local seeds available in the community are not reliable as a result of the presence of pests and diseases that attacks the locally conserved seeds for example rats and also insects like maize and bean weevil. This according to the farmers in the district makes the farmers to lack seeds when it comes to the next planting season. The results of the study in Hoima, Amuria and Gulu districts shows that there is inadequate market for some of the locally produced seeds in the area.

According to the study findings, in Gulu district there is the problem of storage of the local seeds. They stated that if the local seeds are not well kept while in the store, it can easily be destroyed by weevil for example beans and maize kept in the store and that the ground nuts, sorghum if not well kept it can be eaten up by rats. This puts the farmers in tension to keep the seeds for the planting in the next season and in the end they eat and lose all the seeds kept for planting in fear of the pests and insects since insecticides are very hard to get for some farmers. When seeds are kept in the house, smallholder farmers are also more tempted to eat the seeds as food during time of scarcity.

Reasons for Buying Certified or Hybrid Seeds

The study results show that the reasons that push smallholder farmers in Gulu district to buy the hybrid seeds is the commercialization of agriculture where the farmers plants mostly for sale and it is found that the hybrid seeds yields faster than the local seeds and in good quantity hence making business sense though in the long run the use of chemicals destroys the soil hence reduction in the quality of seeds.

In Amuria district, the results revealed that the coming up of the private seed dealers like equator seeds, Victoria seeds and Mukwano as well as the informative, excessive and attractive advertisements that the private seed companies engage in on the media and other channels of communication makes most smallholder farmers to adopt the hybrid seeds.

The study also discovered that the use of hybrid seeds is attributed to the disappearance of the local seeds from the communities in Hoima district though after smallholder farmers engaging with the district officials in the dialogue and exchanging ideas, some community members who had the local seeds started sharing with other. In Gulu district, it was revealed that most of the agriculture related interventions in the region by government and NGOs look at farming as a business hence promoting hybrid seeds of soya beans, sunflower, maize and bean seeds. The FGD in Hoima district indicated that the failure of the local seeds to perform as expected by the smallholder farmers coupled with the change in the market demands is usually what forces the farmers to opt for hybrid seeds in the community. The farmers in Iganga district also testified that the hybrid seeds takes a very short period of maturity and also they continued to note the hybrid seeds dry very fast for example maize and beans where by the local seeds have deteriorated in performance and productivity so if one needs to increase production and productivity it is “a must” he/she has to go for hybrid seed.

In Amuria district the smallholder farmers confirmed that private seed companies make deals with smallholder farmers in providing market for the harvests from the seed they have supplied. Ignorance among smallholder farmers in dealing with the local seeds was also found to be a pushing fact for the farmers to buy the hybrid seeds. Some smallholder farmers cannot even select the local seeds produced and separate it for planting in the next season. Initially they used to harvest and store in the granary and measure a certain quantity of seeds that will be reserved for planting during the planting season but these days most farmers eat all the produce that is harvested and when it comes to planting season, these same farmers have no seeds hence buying the hybrid seeds from the private seed companies.

Ranking of reasons for adopting hybrid seeds;

1. hybrid seeds take a very short period of time to mature hence competing well in the market and solving food problems in the homes
2. hybrid seeds produce high yields compared to the local seeds
3. hybrid seeds are easily accessible in the shops and local markets in the area
4. crops or harvests got from hybrid seeds dry very fast

Perceptions on Farmer Managed Seed System

Smallholder farmers in Gulu district understand FMSS and are practicing it in their communities. Smallholder farmers are working in farmer groups to collect and multiply local seeds for preservation. These seeds are being stored in seed banks and group members are sharing with in themselves as well as some community members. Smallholder farmers decried the fact that their local seeds by law can't be legally shared within their communities and beyond unless it becomes a QDS of which the process takes long and no easy for smallholder farmer. In Iganga district smallholder farmers also testified that they understand Farmer Managed Seed System and they are currently working with other local farmers in the community to provide more information, knowledge and awareness on the local seeds available and the creation and development of FMSS. They also revealed that the community members have appreciated seeds under FMSS. The media fraternity in Amuria district like radios and local newspapers are continuously advocating for communities to conserve local seeds however private seed companies are always de-campaigning the FMSS approach.

However, there are also mixed feelings on Farmer Managed Seed System in Uganda. The study found out that smallholder farmers support and consider FMSS with a positive light but some government officials are so reluctant to support FMSS since they consider farmers as incompetent in seed management. In Hoima district, the government is supporting both the hybrid and indigenous seeds. There is still need for further research and testing of their indigenous seeds in terms of pesticides because farmers still need that knowledge on how their fathers and grandfathers used to do it. They have confessed that if they plant in time and follow the practices then the seeds become resistant to weather changes and this makes them to like the local seeds. Despite the fact the smallholder farmers are willing to promote FMSS, they have limited capacity to organise a FMSS that addresses the need of a larger community and they don't receive any support from government which de-motivates them. Government is mostly promoting OWC approach of distributing seeds to smallholder farmers hence encouraging dependence.

A government official stated that;

“Government is focused on wealth creation and one can't create wealth with local or traditional seeds because they take long yet yield less. Farmers need to be introduced to seeds that will economically empower them not those that will keep them in poverty like local seeds.”

Smallholder farmers involved in the study acknowledged that;

“With constant engagements there will be improvement in quality and access to the local seeds in the community since that seed is very important in food security of rural households because these indigenous seeds are drought resistant and local seeds don't need to spray since chemicals destroy seeds diversity and are cancerous.”

Knowledge on Managing the Local Seeds and Seed Exchange Network

In Gulu and Hoima district, smallholder farmers testified to having a bit of knowledge on how to manage the local seeds given that for generations they have been engaging with the local seeds but they still feel the need for more capacity strengthening in relation to post-harvest management for example storage of the harvested seeds, drying of seeds once they are harvested from the garden and taking good care of the seeds to be planted in the next planting season. More knowledge is mostly needed for seeds of sorghum, cassava, maize, millet and beans. Smallholder farmers also wanted to explore some new crops like garlic and ginger. More results from Amuria district show that smallholder farmers are having no knowledge about FMSS since the old people in the community have passed on. FGD with smallholder farmers in Hoima district revealed that there are existing seed sharing network between farmers in Hoima district and those in Buliisa district. Seed is exchanged mostly during market days, seed fairs and meetings. Apart from seeds, various information and knowledge on managing the local seeds is also shared hence building their capacity in local seed management. The study also reveals that smallholder farmers in Gulu district exchange seed with relatives and friends though in most cases after harvesting, they have to pay back the seeds. Unlike for the case of Hoima and Gulu district, findings show that most smallholder farmers in Iganga and Amuria district are not very much engaged in seed exchange. Most smallholder farmers noted that they are used to receiving free seeds from government and buying seed from the market or friends. Smallholder farmers also attested to the fact that there are existing organisations that are supporting farmers through sensitization and exposure hence creating opportunities for smallholder farmers and network and share seeds and indigenous knowledge on seed management. A staff from an NGO working with farmers said that;

“Very many smallholder farmers appreciate the contribution of managing their own local variety seeds for their seed security and sovereignty though currently they are being brainwashed by some companies that their local seeds are inferior hence the need to run for the new seeds. This is killing the farmer managed seed system.”

The district and NGOs officials interviewed during the KII expressed knowledge of presence of informal seed exchange networks among smallholder farmers. They noted that smallholder farmers are exchanging seeds with their households, farmer groups, social gatherings and markets sometimes even without being keen that seed exchange is taking place. One key informant noted that there is also existence of organised seed exchange networks like those under the Community Managed Seed System where smallholder farmers are actively collecting local seeds from around Gulu district and the region then share them within the members of a particular groups, some groups go ahead to multiply these local seeds and later exchange with other farmers or groups. Some farmers who have a lot of seed are also selling them to other farmers though most seeds that are being sold by smallholder farmers are local seeds and not QDS. It was also noted that seed fairs were also being done mostly supported by NGOs as one of the seed exchange network.

Organizational involvement in farmer managed seed system

Involvement in Promoting Farmer Managed Seed System and Importance of the Interventions

The results of the study shows that there are some NGOs that are promoting FMSS in Gulu, Iganga and Hoima districts. These organisations are involved in building capacity of smallholder farmers using models that promote Farmer Managed Seed Systems. In Gulu district, such organisations are strengthening the capacity of farmers to multiply seeds and create seed banks for mostly local seeds. These organisations have also engaged the district authorities through dialogues, seed fairs and radio programs to build support for on Farmer Managed Seed Systems. In Iganga district, smallholder farmers are involved in seed multiplication, seed collection, seed banking and sharing. In Hoima district, the study revealed that local communities are being facilitated to revive the local seeds through organising internal exchange visits in Hoima and Buliisa district where smallholder farmers would learn from each other and organising farmers' dialogues where they discussed current food status comparing it with earlier decades. After they realized that they had seeds which were resistant to pests and diseases, then they started processes of reviving and discussing seed varieties, the farmers who had the seeds would bring and share with those who did not have. These actions by such organisations have helped smallholder farmers to conserve some of the local seeds in the area hence promoting Farmer Managed Seed System. These organisations have also provided reading materials about seeds and they have also facilitated smallholder farmers to map existing local seeds of indigenous, organic farming using organic pest control and disease control.

Evolution of Work in Promoting Farmer Managed Seed System

Smallholder farmers narrated that in the last 30 years, they had their traditional seeds which had been performing well, but of recent they have started being affected by different pests and diseases. This has attracted researchers who have led to introduction of new seed varieties (hybrid seeds). According to Smallholder farmers from Gulu and Hoima district, about 3 years ago, farmers started acknowledging the need to preserve their indigenous knowledge and protection of the diverse seed varieties in their respective districts. Smallholder farmers envisioned the need to move away from using pesticides and the hybrid seeds that are being promoted by private sector and government. Smallholder farmers started to be reluctant in seeds supplied by the government under NAADS. Women started working together as they developed a habit of sharing seeds and even talk about developmental issues concerning farming and management of local seeds in particular. As a result, farmers have also revived making traditional granaries for storing variety of seeds for planting in the next season.

Almost all smallholder farmers in all the districts mentioned that the NGOs have taken on the initiative of educating farmers on new farming practices on how best to maintain, grow the traditional crops through partnership building and engagements of different stakeholders. This has proven to be very important in production and the promotion of Farmer Managed Seed System in Uganda.

These actions have contributed to improved knowledge among the community in preservation and planting of seeds and this has been as a result of the different stakeholders. Most Smallholder farmers in the study area grow crops like millet, sorghum, cassava, sweet potatoes, groundnuts, beans, peas, bananas, maize, rice and soya beans for self-consumption and for exchange at local markets, nearby cities or through middlemen. Some local hotels and restaurants also directly purchase some of their produce. These are very important crops in the Farmer Managed Seed System. Some crops that smallholder farmers didn't consider priority in the FMSS included pigeon peas, yams, "lamola" and "kali" though they are also traditional crops in the community.

Achievements in promoting Farmer Managed Seed System

As a result of promoting FMSS, smallholder farmers visited in all the district stated that they have been able to promote seed varieties and traditional farming. District officials also appreciated the fact that smallholder farmers are preserving and promoting local and traditional seeds in their respective districts. The promotion of FMSS has also seen many smallholder farmers coming up to be part of the process of reviving the use of locally generated seeds in the community. FMSS have encouraged seed sharing among smallholder farmers in the community and hence creating unity among the farming community. As a result of promoting FMSS, smallholder farmers in Gulu, Iganga and Hoima districts have been able to experience improvements in the quality of seeds being used in their gardens due to the intensity in research conducted and hence improvement in the yields, the improvement in yields has helped to fight hunger in different households. FMSS have been very useful in local seed variety improvement through seed selection like for the case of maize and cassava. This seed improvement has led to the development of local seed varieties and species which are resistant to pests and diseases.

Challenges in the Promotion of Farmer Managed Seed System

The study results depicts that there has been little support given by the government in promoting FMSS through funding and technical support since government mainly looks at modernization of agriculture and programmes like OWC that focuses on improved seeds and hybrids. An interview with CSO representative revealed that there has also been limited monitoring and supervision from the government especially in the production department of what smallholder farmers involved in the FMSS are doing since they aren't target beneficiaries of government seed programs. A local leader in Gulu district also noted that despite the fact that 80% of the seed is managed informally, government hasn't showed interest in issues of FMSS for learning and support. Most smallholder farmers also said that it has not been easy for them to engage the national researchers because most of them despise work by smallholder farmers as unprofessional and untechnical hence it takes some of them a lot of time to appreciate FMSS. Smallholder farmers also decried the fact that the researchers from national research stations who accept to work with them can only support if farmers accept to work with the researcher's terms which normally involves abusing farmer managed seed systems. Smallholder farmers also narrated that attitudes of fellow farmers is still low as most farmers think the government will penalize them if they do not accept the hybrid seeds that are being distributed under different government programmes like OWC. This affects the promotion of FMSS since most of the government programmes don't recognise FMSS neither do they promote local seeds hence affecting FMSS.

Smallholder farmers and local leaders identified the challenge of fake seeds entering the community which makes it difficult for farmers to differentiate between the good quality seeds and fake seeds hence getting no or low yield after planting fake seeds. This affects the way farmers preserve or share seeds in the community. It was also revealed that young men and women are reluctant to take on this initiative of FMSS since it requires a lot of work and collaboration within the community. During a FGD in Iganga district, one farmer said that the law doesn't allow the free sharing of seeds between communities unless they are QDS hence this affects the free choice of sharing seeds, this has also made farmers to share seed in fear.

District official in Iganga district also agreed that smallholder farmers should follow the law while they are promoting FMSS and encouraged farmers to support government programmes that are working towards solving the seed problem in the district. A CSO representative also stated that there is also limited funding, documentation and sensitization of the farmers on FMSS in Uganda.

Impact of Policies and Legislations

The study revealed that most of agriculture policies especially those that are related to seed are still far from being FMSS friendly. Due to acknowledged limitations by national and local governments, smallholder farmers in the study districts have received less assistance from government in relation to promoting FMSS, all smallholder farmers stated that government intervention was only focused on supplying farmers with inputs such as seedlings under OWC as well as offering some basic and limited extension services to the farmers. There is also weakness in the presentation of strategies which is not fully developed by the different partners in the country. Smallholder farmers went on to state that these policies tends to favor commercial farmers and scientists who are pushing on for agriculture biotechnology and also geared by cooperation and powerful seed traders because of their interests. Smallholder farmers also feel like these government policies are market oriented rather than promoting community security and sovereignty.

Smallholder farmers also shared the fact that most local communities are connected to local interests and they feel like the local issues are not well streamlined in the national policy. Smallholder farmers also think that the current farmers unions, cooperative societies are the only ones favoured by these policies but these smallholder farmers promoting indigenous knowledge and seeds are not well catered for. An interaction with one district official from Hoima district said that there is liberalization in the farming system where the government has given chance to various stakeholders leading to counterfeits and poor yields which the government should clearly come out and address. The diversification of the economy in Uganda has opened space for many players to come and participate in farming and therefore not paving way for the local seeds improvement. Findings have also shown that farmer groups and farmer associations plays a greater role in the seed sector but they are always under looked by the government and instead the government promotes the private companies and multinationals. Smallholder farmers stated that they play an important role in ensuring that they preserve and provide quality seeds in the farming system hence the promotion of the local seeds.

CSO representative also explained that when you look at the seed laws, there are a lot of weaknesses i.e. when we see fake seeds and culprits not being comprehended. Farmers are not protected and no follow up is being made, no following of seed chain to have access to seeds by farmers. However the study also revealed that most of the members of the community and the district officials have never come across any of the seed laws. It is realized that indigenous seeds and knowledge is held by old people yet they are not involved in policy processes as they are looked at as aged people who do not have knowledge. It was noted that policies don't recognise that smallholder farmers want these seeds for different purposes like in some communities, the seed was used for performing traditional ceremonies which are looked at as backward cultures and so if it's their right and they are not considered, they will not find their rights in the policies. All these study areas use communal land system where women do not have to own land, they do not have authority over land and yet they are the producers of food like in Hoima district where industries are taking road, women are being denied some land and even when they grow the food, it's taken by men so the rights of controlling seeds is violated and so the right of women farmers. Attaining food security and food sovereignty goes with access to seeds of choice hence when the policies don't support that then smallholder farmers feel like it's a violation of their rights. Smallholder farmers in the study considered that the farmer major rights are land and seed hence all policies should address the challenges affecting farmers' seed and land rights.

Importance of Local and Indigenous Seeds in Food security

The study results shows that the local seeds are very important to the farmers for food security since good quality local seeds like cassava are resistant to drought and other climatic changes and bad weather conditions. Local or indigenous seeds are not only very easy to store for the next plantation season but they are also very important because they address the issues of accessibility, affordability and availability which qualities are important for achieving food security. Smallholder farmers also narrated that local or indigenous seeds are important in food security because of increased production and productivity if well managed by the farmers. According to a CSO representative, the proportion of the locally produced seeds is about 70% of the food produced in the community and districts include the crops like beans, maize, simsim, ground nuts, rice, sweet potatoes, bananas among other. There is no collective effort by most farmer groups or associations to store local and indigenous seeds in groups since apparently farmers are storing seed on individual basis.

A district local leader from Gulu district said;

“Smallholder farmers play major roles in multiplying seeds hence contributing to seed preservation and provide storage for the different varieties of seeds and ensuring that other farmers get seeds ready for the planting seasons”

Challenges facing Farmer Managed Seed System in Uganda’s Agricultural Sector

According to the results of the study, FMSS have a place in the country’s agricultural sector given the fact that many development partners and NGOs are promoting FMSS in different parts of the country. A district official from Hoima district stated that whenever the sub-county/district local government is making a development plan, the production and marketing department includes FMSS though this is mostly because FMSS are promoted by some development partners. In all the district in the study, none of the district have a law promoting FMSS since most agriculture policies despise FMSS. A local leader from Iganga district also noted that FMSS may be playing role at this time in the agriculture sector but in the long run they will be rendered useless because of the current modernisation in the seed sector.

A local leader from Amuria district said that the government has not prioritized FMSS. Results from the study show that there is limited funds for promoting FMSS both in local government and development partners working in the seed sector. There are also few development partners/NGOs working with smallholder farmers to promote FMSS and address the seed challenges in the different communities. A local leader from Gulu district also stressed that FMSS has limited personnel both at the district and at lower levels to provide extension services in the district focusing on seed production, for example in Laroo division is not having an extension officer and there are only 2 veterinary and agricultural officers in the district. Smallholder farmers also noticed that some agricultural extension officers don’t have the skills in working with seeds hence having less appreciation of FMSS. Smallholder farmers also noted that the current agricultural advisory services aren’t focusing on working with FMSS but rather promoting government programmes of OWC and so the government should recruit the Agricultural Extension Officers that are experienced in seed and willing to work with FMSS. Smallholder farmers also think the provision of funds to the seed sector would improve quality and quantity of seeds being accessed by farmers and may also improve the management of FMSS. The agriculture officer of Hoima district narrated that smallholder farmers also lack knowledge and skills about seed management hence the need to train farmers on the ways to store seeds in order to have quality seeds for planting. They also stated that many smallholder farmers are not planting quality seeds hence the need to train them in selection of seeds. The results of the study shows that the government programmes like OWC has negatively influenced FMSS in the different districts since OWC mostly promote seed distribution rather than promoting FMSS.

Improving Farmer Managed Seed System in Uganda

The farmers in Gulu district pointed out the need for capacity building in developing and promoting FMSS in order to improve on the FMSS and lead government to appreciate it. In Hoima district, the smallholder farmers proposed the need for government and other stakeholders to provide them with more knowledge and exposure about these local seeds through trainings and field visits. Farmers in Iganga also proposed that government should provide funds to district local government for seed preservation and seed sector development. In Amuria district, the farmers called for the need for local seed identification. They stressed that the government and NGOs should go to their community and identify the important local seeds available for planting, collect the local seeds from different people then multiply the seed from within the community, they proposed the use of the farmer field school training mechanism. Smallholder farmers from Amuria district also suggested that government should encourage and promote the production of local seed by controlling the prices of the local crops in the local markets. They also suggested that the community should be sensitized and trained on the post-harvest management of the local seeds in order to improve on the FMSS. A district official for Iganga district local government pointed out the need for building capacity of farmers as a way of improving the local seed management.

According to the study, the results indicates that the government should recognize the FMSS and focus on policy formulation and laws that would promote FMSS. There should also be strengthening of the monitoring and implementation of the FMSS. There is need to have clear and proper engagement with researchers on issues of preserving local seeds, smallholder farmers proposed the need for building a strong working relationship between farmers and researchers in order to improve the performance of the local seeds. Documentation and dissemination of information on FMSS should also be done to inform the next generation of farmers and also improve on the yields and production levels of the farmers in different communities. This can be done through encouraging community dialogue about indigenous seeds and through sensitizing the farmers on post-harvest management and food security programs. Smallholder farmers in Amuria district also suggested the need to support them and be given an opportunity to preserve these indigenous crops. Smallholder farmers also suggested the deliberate promotion of indigenous foods hence directly promoting of local seeds. There is need to support smallholder farmers to come up with ways on improving food nutrition using indigenous seeds since they are nutritious. There should be facilitation of exchange learning system where different communities come together to discuss about these local and indigenous seeds, and support programs and organizations which are promoting this to increase on their capacity and scope as they support this work. Also the government needs to analyze further the policies driven by these big cooperatives and companies which targets making profits. Some smallholder farmers suggested the need to encourage agroecology and this goes with organic farming.

Discussion and conclusions

Introduction

This chapter presents the detailed discussion and analysis of results of the study and conclusions.

Smallholder farmers' land and seed rights

Land is an important asset for people's livelihoods and economic development in Uganda, where the majority of people live in rural areas. In the national land policy, the government emphasises the role of land in Uganda's socio-economic development and the importance of efficient land use (MLHUD, 2014). The results from the study show that all the communities visited had customary land systems. Other studies have shown that access to customary land is generally administered by different types of customary land tenure institutions in which kinship is important.

Land is often administered by extended family linkages (Quan 2000). For the same reason, land is often subject to restrictions on transfers outside the family and the clan. Results from a study by FAO in 2011 showed that 39% of women own land sole or jointly compared to 60% of men while only 14% of women own land sole compared to 46 of men in Uganda. Evidence from other studies also points to a substantial and pervasive gender gap in land ownership, with women owning less land than men that is of lower quality (Doss 2006; Mason and Carlsson 2004; SOFA Team 2011). Land is also, increasingly, being seen as a commodity and the demand for land is on the increase. Access to land and land rights for women are critical to development and poverty reduction in households as well as to the success of farmer managed seed system. Smallholder farmers' seed and food security are likely to be affected more by ownership of land because the study ascertained that farmers decision of crops and amount of land to be used was dependent on land ownership in that particular season.

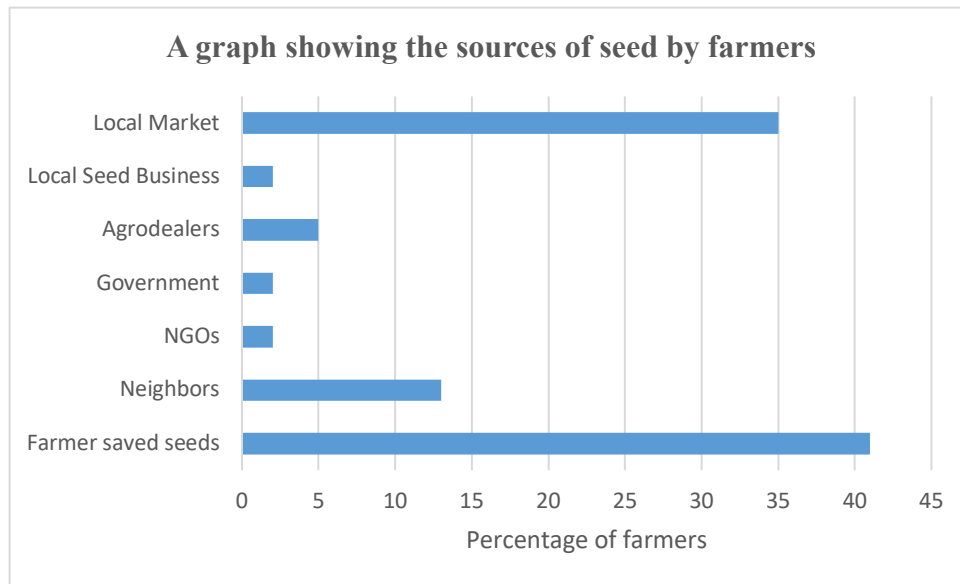
Seeds are key to development. They are first and foremost source of all food and agricultural production. Seeds are genetic resources and carry plant genetic diversity. Smallholder farmers play an important role in Uganda's food systems, with some estimates showing that they meet up to 80 percent of the population's food needs. Seeds are very instrumental inputs that determine development of agriculture among other factors. Findings from the study reveal that seed is an important vehicle for improving agricultural output, and major development goals such as food security, sustainable rural development and poverty reduction. Seed is a crucial input in any form of crop production and one of the most precious resources in farming. Seed has to be available for every crop production cycle and has to be there at the right time, in the right quantities, with the right qualities and at the right price so farmers can access the seed they need (Gregg & van Gastel, 1997). Availability can also be challenged when farmers depend on purchased seed. This can happen when a seed provider is unable to supply seed at the right time, when logistics are poorly organised or when the least profitable (remote) markets are supplied last or not at all (Kugbei et al., 2001).

The use of good quality seed and planting materials of high yielding varieties significantly increases crop production. It is essential that it is available on time and place at affordable prices. The right of farmers to save, use, exchange and sell farm-saved seeds and other propagating materials is a central component of Farmers' Rights as enshrined in the FAO Treaty on Plant Genetic Resources for Food and Agriculture of the FAO (the FAO Treaty). Without seeds we cannot grow our food. Seeds are the part of biodiversity that feed most people. Seeds are self-replicating and a resource which farmers can own and control to adapt to their needs.

Major groups and food crops identified in the study areas

Major Cereals	Small grain cereals	Legumes	Oil seed crops	Roots/tuber/bananas
OPV Maize	Finger millet	Beans	Groundnut	Cassava
Rice	Pearl millet	Cowpea	Sesame	Sweet potato
	Sorghum	Pigeon pea	Soya bean	Potato
		Field pea	Sunflower	Yams (cocoyam)
		Green grams		Bananas & plantains
		Bambara nuts		
		Chickpea		

Seeds are unique in resource economics since they are simultaneously the ‘means of production’ and also the ‘end product’ for consumption. Quality seed is a key input for agriculture with an immediate effect on agricultural production and productivity. The seed sector in Uganda is characterized by the formal and informal systems that are co-existing. The farmer managed seed system which in this case is considered as the informal system is responsible for 85% of seed planted in Uganda. In FMSS, seed is sourced mainly from farm-saved seed from previous season’s crops and community based seed multiplication and dissemination. Although the system is unregulated, it has been found to be very effective in addressing seed challenges in communities. Women play a pivotal role in farmer managed seed system, including in variety selection, multiplication, seed condition and seed marketing. This contributes significantly to food and seed security. Despite the fact that this system is usually unregulated, smallholder farmers’ quality assurance is largely based on mutual trust. Understanding the various crops grown provides information on seed utilization by farmers in the various locations. The study found that farmers grow a number of crops often in pure stand but mainly in mixed patterns or intercrops. Other studies indicate that about 89% of the farmers obtain seed from informal sources, majorly from their own saved seed (ISSD, 2014). Other important sources of seed are local market and neighbours.



Source: Calculation from ISSD Uganda, 2014 study

Impact of treaties, laws and policies on FMSS

Seed is an important vehicle for improving agricultural output, and major development goals such as food security, sustainable rural development and poverty reduction. The importance of seed in agriculture has made seed an issue in national and international policies. Its multiple roles, moreover, makes it vulnerable to policies that may not be directed at seed itself or even at agriculture. Without seeds, there is no harvest, no food, no life. Around the world, this vital input is made accessible by farmers' own work to recycle and save seeds from their crops, and through farmer to-farmer gifts, exchanges, and trade. (Oakland Institute, 2017). Seed regulatory frameworks impact on the development of seed systems and need to be designed carefully in order to promote the development of local seed systems and to support the integration of knowledge and materials among these into a diverse seed system. The development of policy and regulatory frameworks affecting seed systems shows a disconnection between parallel policy processes on the one hand and between policies and everyday agriculture on the other.

The 1991 Convention made the farmers' privilege explicit by allowing member states to specify crops for which the re-using of farm-saved seed on the same farm would be allowed. This clause rules out any transfer of seed through sale, barter or gift among farmers. Within UPOV the farmers' privilege issue was specified in 1991. It was implicit in earlier Acts that farmers should be allowed to save and reuse seed, but some countries had a very wide interpretation of the clauses on non-commercial use resulting in very limited opportunities for rights holders to exercise their rights. Seed laws regularly also protect the seed developer and producer from unfair competition, through measures such as a certification system, quality standards, and accreditation and authorization procedures (FAO, 2015). The challenge for policymakers is to create policies and laws that support each of these various seed systems where they are most effective (Louwaars et al., 2012; FAO, 2015). Even where seed policies recognize farmers' seed systems, seed laws may concentrate entirely on the formal seed systems, ignoring their potential impact on farmer managed systems.

The Seeds and Plant Act, 2006 and the draft National Seed Policy do not address the right of farmers to use, exchange, and sell their saved seeds. The Seed and Plant Act 2006 is a legal framework that provides for the promotion, regulation and control of plant breeding and variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and other planting materials. The Act aims at increasing the productivity, profitability, and sustainability of cropping systems. The Act recognizes and protects the rights of breeders to varieties that they develop and promotes the supply of good quality seed and planting materials; however, it does not recognize farmers' rights. The objective of National Seed Policy is to ensure the availability of adequate, high quality and safe seed on the market in order to increase agricultural production and productivity for improved standards of living and food security. The policy aims to create a well-regulated national seed sector that ensures access and availability of seeds of high quality and planting materials produced in diverse seed systems. The policy recognises both the formal and informal seed systems. The policy also recognises the addition of a Quality Declared Seed (QDS) class to bridge the gap between formal and informal systems. The policies and laws have heavily been in favour of the formal seed sector, which serves only a small minority of farmers in the country. Most of these policies and laws have weak support for the farmer managed seed supply system.

FAO recognizes that farmers have contributed greatly and continue to contribute to the creation, conservation, exchange and enhancement of genetic resources, and that they should be recognized and strengthened in their work. (FAO, 1989). Uganda has an integration of both formal and informal seed systems, the formal seed system being a deliberately constructed and bounded system, while the informal seed system embraces most of the other ways in which the farmers themselves produce, disseminate, and access seed. Tripp and Rohrbach (2001) have looked into community level seed enterprises as an alternative for new, non-hybrid crop varieties. As the seed industry in many developing countries is unable to provide farmers with adequate access to quality seed, the farmer managed seed system will continue to be farmers' main source of seed (FAO, 2015). Farmers in Uganda produce between 80%-85% of their seed themselves (ISSD, 2015). Over time, farmer managed seed systems have assumed multiple functions and delivered a variety of services including conservation of plant genetic resources, enhancement of access and availability of local crop diversity, and seed and food sovereignty. Like other related studies, this study emphasises that the role of farmer managed seed system is not only poorly recognized, but opportunities to strengthen it to contribute to local and national food security are underexploited by both government and private sector.

Influence of public and private institutions and organisations on FMSS

The government of Uganda started being involved in the seed sector in 1968 with the guidance of MAAIF as a seed multiplication scheme and became operational in 1970 with support from Overseas Development Agency (ODA) (ISSD, 2015). Since then the government has played different roles in the sector including registration of other actors, seed certification, sector regulation, quality assurance/standards and research and policy formulation. The National Agricultural Research Organization (NARO) runs public breeding programmes for major crops, and is responsible for the production of breeders' seed and early generation seed. The National Agricultural Advisory Services (NAADS) through Operation Wealth Creation (OWC) facilitates access to seed and planting materials for smallholder farmers. The Crop Protection Department of MAAIF is in charge of seed company licensing, variety release and cataloguing; import and export regulations; and seed quality assurance. The National Plant Genetic Resources Centre (PGRC) is responsible for ensuring genetic diversity and conservation in Uganda. The public sector has mainly been concerned with major food crops, such as maize, beans and cassava while for smallholder cash crops like cotton and coffee; they support the private sector, but also intermediary and more informal seed systems.

Results from the analysis also show that there is insufficient support for farmer seed systems and this is evident with the policies and laws that are being developed and passed by government. Government has mainly focused its efforts to empowering the formal seed system that focuses on breeding, producing and selling seed that is certified by the National Variety Release Committee (NVRS).

Government hasn't taken steps to monitor or control the informal seed system by enacting government policies and regulations that focus on informal seed systems. This has left the informal seed system to be guided by indigenous knowledge and standards.

The government program of free seed distribution to farmers distorts market dynamics and negatively impacts the seed distribution networks. Analysis of the result show a collapse of public seed sector apart from research and seed breeding, most of the roles in the sector like seed production, processing and packaging, seed education, training, extension, distribution and sales are done by the private sector. Uganda's seed industry is fully privatised. In 2015, there were 13 registered seed companies in Uganda that either produced or marketed the four crops. (TASAI, 2015). The involvement of private sector companies in the seed sector and also had an impact on farmers perception toward seed bank storage as some farmers prefer being dependent to the seed supplier sighting the different advantages. Analysis show that assumption of quality has played a big role in driving farmers to buying seeds from seed dealer.

There are many organisation (CSO/NGOs) in Uganda that are actively doing seed work with smallholder farmers at different levels. Most of these organisations are using different models and most of them aren't sharing any information among themselves. Organisations are engaging smallholder farmers in different ways including working with farmers to influence seed related policies, distribution of seed to farmers, building capacity of smallholder farmers in seed multiplication and quality managements, empowering smallholder farmers in local seed business, carrying out research on seed and building linkage between government institutions dealing with seed and the smallholder farmers. These interventions by the different organisations have led to access of quality seeds by smallholder farmers. Quality seed production is the most essential component in increasing yield thereby income for farm households (Lipton, 2005). These organisations have contributed a lot to addressing the seed insecurity of smallholder farmers though they have done little to promote seed sovereignty since most of them aren't focusing on the farmer's rights to save, breed and exchange seeds, to have access to diverse open source seeds which can be saved but rather working with seed from research organisations and emerging seed giants. It should be noted that very few organisations were found focusing on FMSS and local seeds as some may indirectly consider smallholder farmers incompetent to save what they refer to as "quality seed" and consider local seed outdated implying that those seeds can't withstand the current climate changes. These actions by different organisations have left smallholder farmers confused on how best they could address their seed challenges. The reason why most organisations aren't focusing on FMSS and local seed might be because most of these organisations are aligning their interventions with government programs which in most cases aren't in support of FMSS and the use of local seeds by smallholder farmers.

Seed knowledge and management

Seeds have long been a part of the cultural heritage of different societies in Uganda, seeds are an integral part of many rituals, ceremonies and festivals that celebrate the cycle of birth, life and death. The practice of seed saving has been a cornerstone of farming communities that made agriculture their way of life. Analysis from the study showed that it's only the elderly in the community that had knowledge about lost seeds varieties as well as knowledge about how seed was persevered and how seed should be preserved. Despite the fact that there are some farmer who are still have some indigenous knowledge on farmer managed seed systems, some farmers consider it irrelevant. With the introduction of the improved seed varieties eroded the diversity of some indigenous seeds as smallholder farmers moved away from the practice of saving and exchanging seeds with their neighbours and families, to buying seeds from the market. This led to the loss of their indigenous knowledge on systems related to farmer managed seed systems. Currently some smallholder farmers aren't making an effort to learn about FMSS since it has been fronted as an outdated way of managing seed. Women smallholder farmers have ever since played a very important role in seed management though this intimate knowledge that they possess is often devalued by some community members, educated researchers and the government institutions.

The unequal decision making power in households in rural communities has also impacted negatively on women's utilisation of their seed knowledge. With the growing climate unpredictability and increasing expenses for external farm inputs, it's clear that the traditional knowledge of seed selection and conservation in FMSS is critical to the future given the fact that the increasing concentration on the commercial seed breeding industry has contributed to the erosion of this crop diversity.

The food insecurity situation in the county has also affected the progress of farmer managed seed systems among smallholder farmers. Control, ownership and affordability of seeds are of crucial importance to the food security and resilience of smallholder farmers. Food Security is achieved "when all people, at all times have physical and economic access to adequate/sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (WHO, 2015). The Food Security Analysis done by MAAIF in collaboration with other stakeholders in July 2016 indicated that at national level, the country experienced an average crop loss of approximately 40% for pulses (beans, groundnuts, peas) and 80% for cereals (maize, millet, rice, sorghum) from the first season harvests. The most affected crop was maize (Ssempijja, 2017). This level of food insecurity in some communities has made smallholder farmers adopt to fast growing seeds that are released by research organisation rather than some local seeds that they are keeping in their seed systems will soon lead to the extinction of indigenous seeds. The food insecurity situation has also caused smallholder farmers to be trapped in government's solution of adoption and use of modern agricultural technology which include seeds hence not recognising farmer managed seed systems. Despite the fact that farmer seed networks can provide quality planting materials that are acceptable to farmers (Sperling and McGuire, 2010b), there has been discussions on the benefits of modern plant breeding that can reach farmers only through an efficient seed system hence an urgent need to develop the private seed sector" (World Bank, 2006: 25).

Pressures of climate change on FMSS

With the current challenges facing agriculture sector resulting from climate-induced stresses, building resilience is a priority. The changes in climatic conditions which is associated with increased frequency of extreme weather events influence the whole crop system, i.e. rainfall patterns and dynamics hence leading to hazardous events like droughts, floods, pest and disease outbreak. This leads to a direct impact on crop production practices like field preparation, planting and other general field management practices. Farmer managed seed systems are important for enhancing such resilience as seed security has direct links to food security, and resilient livelihoods in general. Drought cycles seem to have shortened to every 2-3 years instead of 5-7 years in the past. Changes in climatic conditions influenced the cropping cycle, field preparation, planting and field management practices, and subsequently the expected yield. The effect of climate change and global warming is posing great danger to agricultural productivity. Smallholder farmers are greatly affected by current climate change and variability. The impact can be felt on crop production and seed systems in relation to failed or successful crop yields. Smallholder farmers have lost trust in their own stored seeds hence they depend on access to so-called good quality seed from seed traders which is believed to be well-adapted, productive crops to allow them to produce the best possible crops. For some farmers to adapt to climate change, they obtain seed from multiple sources. Multiple sources provide options which allow farmers to shift crop or variety portfolios in response to changing conditions (McGuire and Sperling, 2013).

Farmer managed seed systems have not been recognised for the contribution to climate change adaptation yet farmer managed seed systems are repositories of local genetic diversity that is often adapted to prevailing climate conditions. This system has proven to be useful in contributing to community based strategies for adaptation to climate change. It has been urged that locally available seeds are not always adapted to new circumstances yet these same seed have withstood for some many years since the climate started changing.

Efforts by other seed sector actors to discredit local seed and farmer managed seed system by promoting climate resilient varieties are baring fruits in some communities as some few smallholder farmers testified that they're depending on seed varieties from government or from the market because they are said to be climate resilient varieties. Because smallholder farmers consider the effects of climate change on crop production to be related to the diminishing levels in quantity and quality of the affected crop resources yield, some farmers are integrating agroecology practices into their seed management systems as a way of enhancing their resilience potential amidst effects of climate change. This in a way is keeping some farmers hopes high on local seeds and if sustained, smallholder farmers will be seed secure without having to surrender their local seeds.

Market influence on FMSS

The market has played a critical role in promoting or challenging farmer managed seed systems in Uganda. Related studies have showed that the formal system which is regulated by Government contributes only about 15% of total seed supply. The remaining 85% of seed is produced through the informal system that is unregulated and depends on farm saved seed from previous cropping. This shows that majority of seed planted by smallholder farmers has been selected and saved back from the previous year's harvest or sourced from neighbouring farmers in the local vicinity under the farmer managed seed system. According to the policies and laws of Uganda, The selling of farmer saved seed on the market is illegal unless it goes through the process of being quality declared. Quality Declared Seed (QDS) has been introduced to reduce the use of home-saved seeds as a transition into the formal seed system seed system for the major food and cash crops. The draft National Seed Policy 2014 adds Quality Declared Seed (QDS) as the sixth class. QDS requires minimum field inspection and certification standards for variety purity and germination. The fact that most farmers in the farmer managed seed systems aren't aware of QDS or don't consider it a relevant issue mostly because even before the law they were sharing seed, they end up being caught on the other side of the law hence this will in the end discourage FMSS. This also makes the seed market not legally accessible for most farmers who would have multiplied seeds of local varieties that are rare and unique or which are becoming less available to farmers, and making them available every season under the farmer managed seed system who would have loved to sell their seeds on the market. This will contribute to the disappearance of most of the indigenous seeds that aren't a focus of the seed companies and government since seed sharing is put of conservation.

Studies have also shown that both the public and private suppliers are unable to provide adequate seeds according to the demands in the market. This justifies the need for development and promotion of farmer managed seed system.

Conclusion

The agricultural sector is of vital importance for the development of Uganda. It is undergoing a process of transition to a market economy, with substantial changes in the social, legal, structural, productive and supply set-ups, as is the case with all other sectors of the economy. Adding to the growing body of evidence, this study points to significant contribution of FMSS in the national seed system in Uganda. Further, it sheds light on the importance of preserving FMSS in achieving seed security and sovereignty of smallholder farmers. Seed is an essential element in crop production, representing a valuable resource that is important in sustaining the supply of food. Seed is also essential for rural development and poverty reduction hence the need to appreciate FMSS as the solutions to the availability and access to quality seed.

Recommendations

Recommendations for different actors for follow up, based on the findings and conclusions

There is need to strengthen the capacity of smallholder farmers that are engaged in saving seeds to value and protect these local genetic resources and related knowledge amidst the current unfavourable policy environment. This will greatly contribute to the conservation and recovery of local plant species and varieties maintained by smallholder farmers.

Build capacity of community seed banks to strengthen their technical and managerial expertise in alignment with the policies governing seed in the country. More farmers should be encouraged to develop QDS seed hence promoting the practices of community seed entrepreneurship that may lead to increasing the availability of local seeds in communities and also lead to the appreciation of the contribution of FMSS to the seed sector.

There is need to promote the documentation of local and indigenous seed varieties in the country and their contribution to food sovereignty and nutrition under the farmer managed seed system. Widely sharing such information may lead to practice and policy change in favour of FMSS.

Different stakeholders should do more in valuing and rewarding smallholder farmers with successful initiatives in farmer managed seed systems. This should motivate other groups to come up and promote FMSS.

There are need for smallholder farmers, farmer organisations and CSO to display collective efforts in safeguarding agricultural biodiversity and associated cultural values and knowledge. This can be achieved through disseminating and promoting the results realised by smallholder farmers involved in FMSS.

More research is needed to be done in the area of FMSS sustaining in the changing climatic conditions which has increased smallholder farmers dependence on private seed companies.

The disappearance of local varieties and erosion of genetic diversity are mainly due to external intervention. There should be support for smallholder farmers technically and financially to organise themselves to be able to exchange knowledge and experiences, and strengthen their organisational capacity in managing and promoting farmer managed seed systems.

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